CONTRIBUTION

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Space photos detect changing currents along the Texas coast

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PHOTOGRAPHY of the earth from manned spacecraft brings a new dimension to the study of fishery oceanography. Many ocean features such as coastal currents, wakes around islands, and the flow of waters in and out of bays and estuaries have been photographed along thousands of miles of coastlines. For the first time, oceanographers are beginning to learn details of the complicated currents that always occur nearshore.

The flight of Apollo 9 in March 1969 was the final scheduled earth-orbital mission in the Apollo program. Consequently, marine scientists in Galveston were eager to obtain photographs of ocean conditions that had been previously recognized as being important to the distribution of shrimp larvae and to the development of nutrient-rich waters around islands. Because of the great interest and cooperation of the astronauts, Col. James A. McDivitt, Col. David R. Scott, and Russell L. Schweickart, the photography surpassed all expectations.

Perhaps the most significant contribution of the photography from Apollo 9 is the repeated coverage afforded of certain ocean areas. Furthermore, because the flight was in March, at the end of the northern winter, water conditions never seen before were photographed. Consequently, photographic sequences now are available of coastal waters where the seasonal currents vary greatly. One of the most important of these areas from the standpoint of the nearshore currents is the central Texas coast.

The photographs of Galveston Bay, Texas, that were taken on March 8 and 9, 1969 from Apollo 9, provide valuable information about the winter nearshore currents.

The coastal currents are less turbulent in November through March than during the rest of the year because of the dramatic decrease in winds from the southeast. Cold fronts, followed by northerly winds, cross the Texas coast every 2 to 4 days in the winter. These winds blow in a direction more or less opposed to the currents in the Gulf of Mexico, thereby decreasing both sea level and the speed of the coastal currents in the northwest Gulf. As a consequence, the nearshore waters move slowly, sometimes reverse directions, and are far less turbulent than in the summer and fall.

Winds at Galveston on March 7 were from the east and southeast at speeds of 14 knots. A cold front passed during the early morning of March 8, and winds had shifted to north at 15 knots at the time the photo opposite upper left was taken. The air was dry (relative humidity about 35%), and the skies were clear over the coastal plain and nearshore waters.

The movements of water in the estuaries and the nearshore Gulf on March 8 could be seen because the water was muddy. The amount of sediment passing through the lagoon inlets was small because of the extremely low river flows in the early months of 1969; the muddy water present was produced mainly by wave action over the shallow lagoon and bay bottom.

By 2 pm on March 8 very little turbid water was coming out of Galveston Bay because the muddy water in the upper bay had not yet reached the mouth of the bay. Thus, the color variation seen in the turbid water between the Galveston jetties was in response to water depth. The dark colors marked the dredged channel; the light color indicated the sand bars on either side. Outside the jetties and seaward of the entrance, muddy water coming from east of Galveston flowed smoothly around the jetties. There was no evidence of the great turbulence near the coast that exists in the summer and fall (photo upper right opposite.)

Farther west, especially near Freeport, the turbid water formed patterns that showed the dominance of the northerly winds on the movements of surface water. The nearly linear seaward flow of muddy water matched almost precisely the Eckman flow of surface layers (i.e., 45 degrees to the right of the wind direction).

The non-turbid water from the Freeport Ship Channel made a clear break in the thin muddy layer of the coastal sea. An extremely minor flow from the Brazos River is visible as muddy water, which was caused primarily from the waves breaking over sand bars.

After northerly winds blow for 24 hours or so, and especially if they "back" to the northwest, a current reversal takes place (lower photo opposite). The nearshore turbid water, aided by the tide, moves offshore, and most of the sediment settles to the bottom before winds change to an east and southeast direction.

The light discoloration some 20 miles seaward from Galveston Island represented the remains of the muddy water blown offshore when a front crossed the Texas coast on March 5, three days before the first Apollo 9 photograph was taken. Northerly winds blew until midnight on March 6 and produced a water movement similar to that seen at upper left.

Apollo 9, therefore, provided oceanographers with outstanding pictures of waters photographed previously during earlier missions of Gemini and Apollo. The total value of this repetitive photography cannot be truly determined. In the waters of coastal Texas, however, the information gained from Apollo 9 removed the necessity of a complex ship survey to learn the details of current movements such as those just described. Such an effort would cost between $2 and $4 million. Samples from the coastal sea are still required to relate the biological constituents to these current patterns, but we now know where the sampling locations should be.

Summary. Photography from space has proven to be of direct, estimable value to fishery oceanography. Were no other sensor than a camera ever to fly, the capability of repetitious, synoptic-scale photography would revolutionize man's use of ocean resources. It is clear, however, that photography for oceanographic purposes without human control loses value. The opportunity to select times, places, and features of significance far outweighs in value continuous indiscriminate photography.

It is imperative, therefore, that a manned, earth-resource, experimental program be carried out in the next decade. In this way, the proper selection of times, sensors, data points, and detail can be determined so that scientists will not become smothered with information that has been derived irrationally. ■

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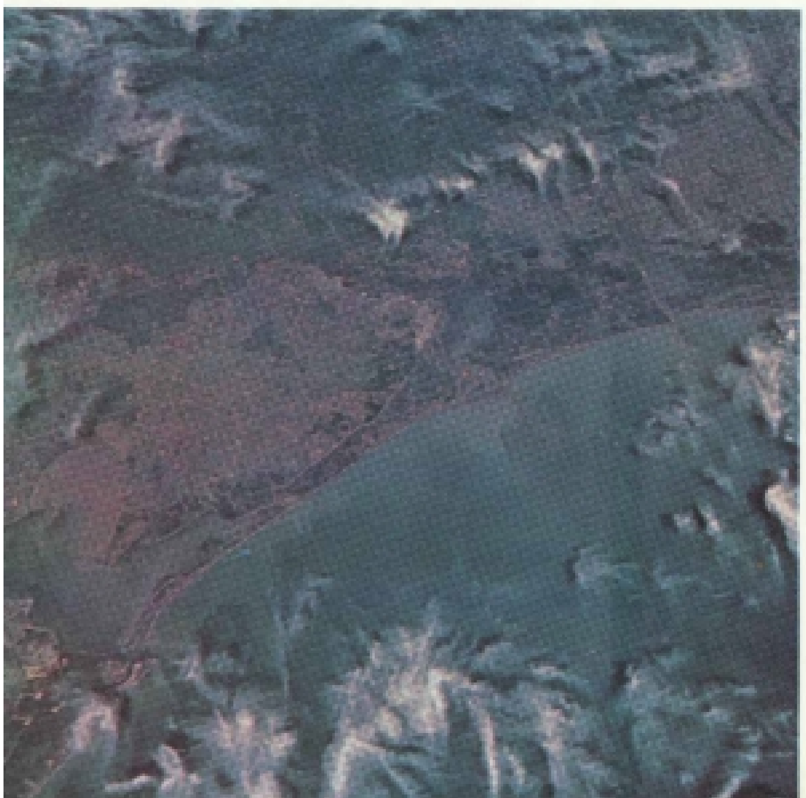

The Texas Gulf coast (upper left) from Matagorda Bay to Galveston Bay, Apollo flight 9, March 8, 1969, by astronauts Col. James A. McDivitt, Col. David R. Scott and Russell L. Schweickart. (Infrared film)

The Texas Gulf coast (upper right) from Corpus Christi to Galveston Bay, Apollo 7, on October 14, 1968, by astronauts Capt. Walter M. Schirra, Maj. Donn F. Eisele and R. Walter Cunningham.

Coastal waters in the Gulf of Mexico from Galveston Bay, Texas, to Lake Calcasieu, Louisiana, Apollo flight 9, on March 9, 1969, by Col. McDivitt, Col. Scott and Schweickart.